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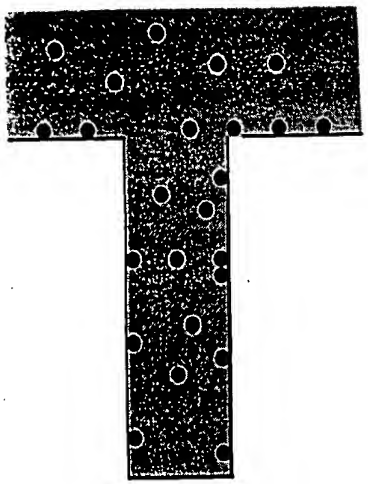
FIG. 15

How Much Additive Comes in With the Solution?



Ratio:

Surface to Solution Molecules

Aspect Ratio				
2	299	60	155	52
2.5	365	73	190	63
3	432	86	224	75
3.5	498	100	259	86
4	565	113	293	98
4.5	631	126	327	109
5	697	139	362	121
5.5	764	153	396	132

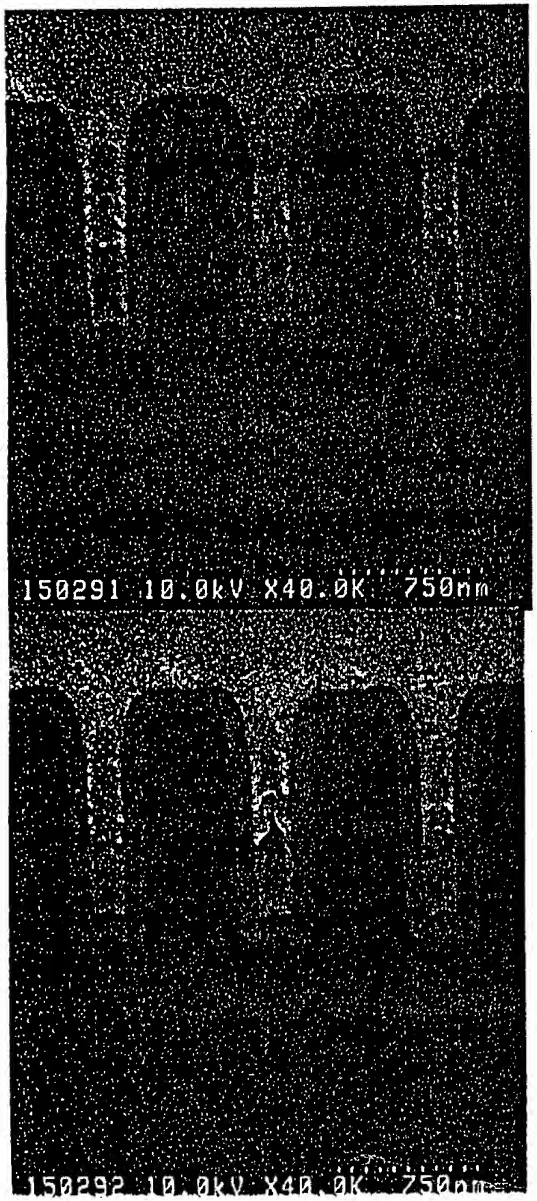
Conditions				
ppm	20	100	100	300
~~Mn~~ MW	100	100	3000	3000
Moles/~~u^3~~ um^3	2.0E-19	1.0E-18	3.3E-20	1E-19
Molec/~~u^3~~ um^3	120460	602300	20077	60230
Molecules size (nm)	0.5	0.5	1.7	1.7
Molec/~~u^2~~ um^2	4000000	4000000	346021	346020.8

Conclusion: At all expected additive condition, there is insufficent material stored in the inital solution within the via to lead to substantial surface absorption in the via.

-There will be an absorption time delay.

FIG. 47

Without Initiation: Ti-IMP seed:



- SEMATECH Backfilled via , Field 3 , 0.24 μm x 1.13 μm, AR = 4.7
- Bottom Voids- Yes
- Side wall Voids - No
- Top Void- No
- Center Seam - No
- Film nucleation-poor
- Void % = 90%
- 2 second induction

Barrier/Seed Layer

-Ti-IMP
-250Å Ta/1600Å Cu
-Degas Temp. ?
-Sputter etch thickness: ?
-wafer bias: ?

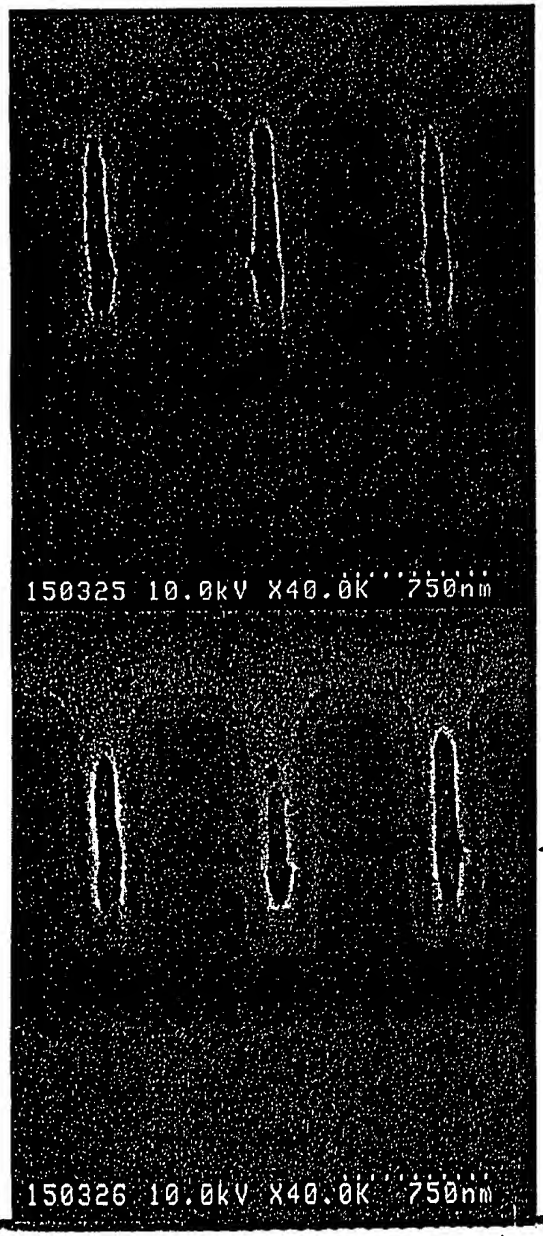
Electroplating

-DC, 7 A
Bath Conditions

$[Cu^{+2}]$ = 17.3 g/l	H_2SO_4 = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
$[Cl^-]$ = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125

FIG. 48

With Initiation: TI-IMP seed



- SEMATECH Backfilled via , Field 3 , 0.24 μm x 1.13 μm, AR = 4.7
- Bottom Voids- Yes
- Side wall Voids - No
- Top Void- No
- Center Seam - No
- Film nucleation-poor
- Void % = 70%
- 2 second induction

Barrier/Seed Layer

-TI-IMP
-250Å Ta/2200Å Cu
-Degas Temp. ?
-Sputter etch thickness: ?
-wafer bias: ?

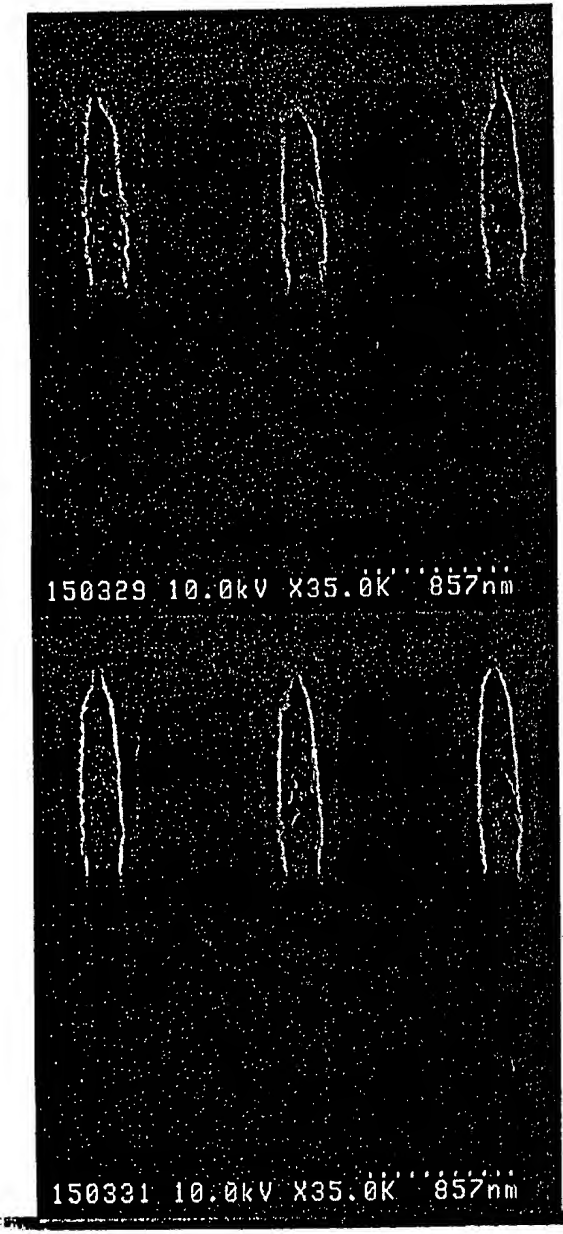
Electroplating

-DC, 1 A, 15 sec then 7 A
Bath Conditions

$[Cu^{+2}]$ = 17.3 g/l	H_2SO_4 = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
$[Cl^-]$ = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125

FIG. 49

Without Initiation: TI-IMP seed



- SEMATECH Backfilled via , Field 2, 0.29 μm x 1.14 μm, AR = 4.0
- Bottom Voids- Yes
- Side wall Voids - No
- Top Void- No
- Center Seam - No
- Film nucleation-poor
- Void % = 90%
- 2 second induction

Barrier/Seed Layer

-TI-IMP
-250Å Ta/1600Å Cu
-Degas Temp. ?
-Sputter etch thickness: ?
-wafer bias: ?

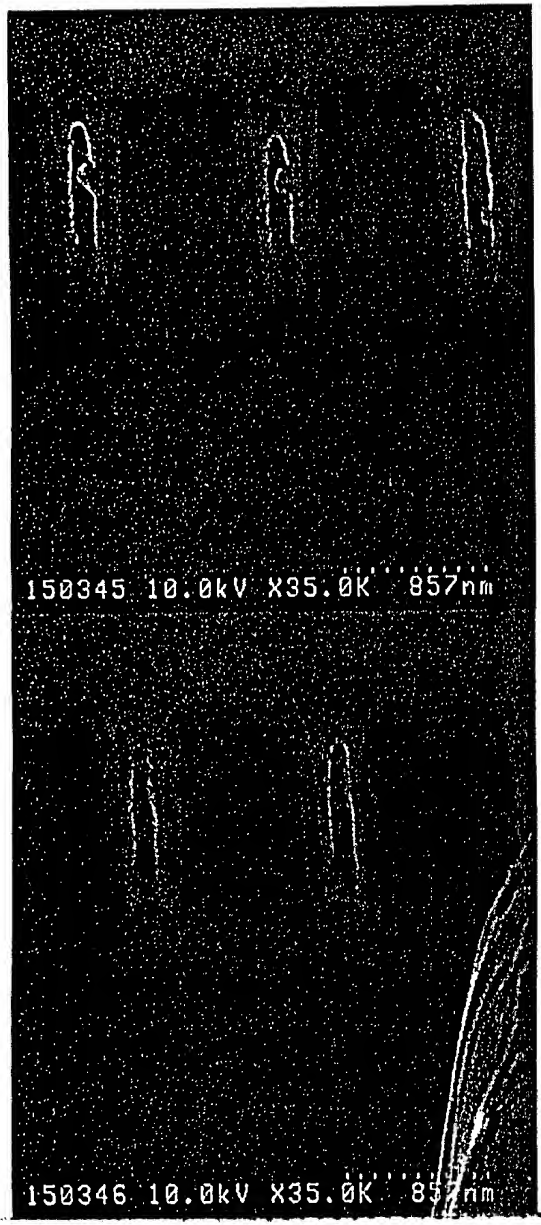
Electroplating

-DC, 7 A
Bath Conditions

$[Cu^{+2}]$ = 17.3 g/l	H_2SO_4 = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
$[Cl^-]$ = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125

FIG. 50

With Initiation: TI-IMP seed



- SEMATECH Backfilled via , Field 2, 0.29 µm x 1.14 µm, AR = 4.0
- Bottom Voids- Yes
- Side wall Voids - No
- Top Void- No
- Center Seam - No
- Film nucleation-poor
- Void % = 60%
- 2 second induction

Barrier/Seed Layer

-TI-IMP
-250Å Ta/2200Å Cu
-Degas Temp. ?
-Sputter etch thickness: ?
-wafer bias: ?

Electroplating

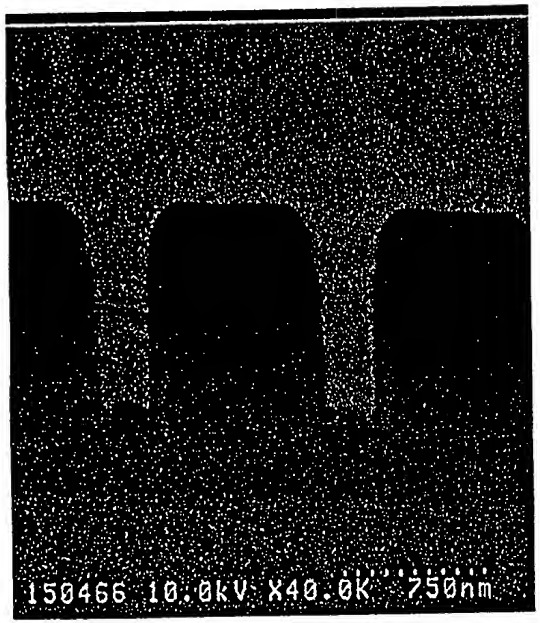
-DC, 1 A, 15 sec then 7 A

Bath Conditions

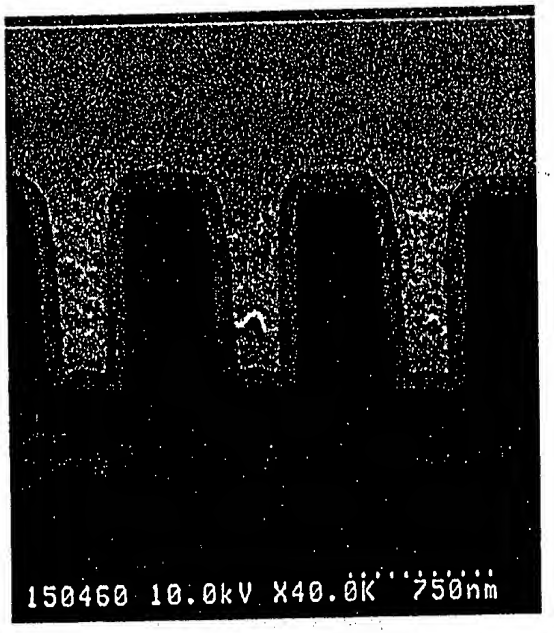
$[Cu^{+2}]$ = 17.3 g/l	H_2SO_4 = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
$[Cl^-]$ = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125

FIG 51

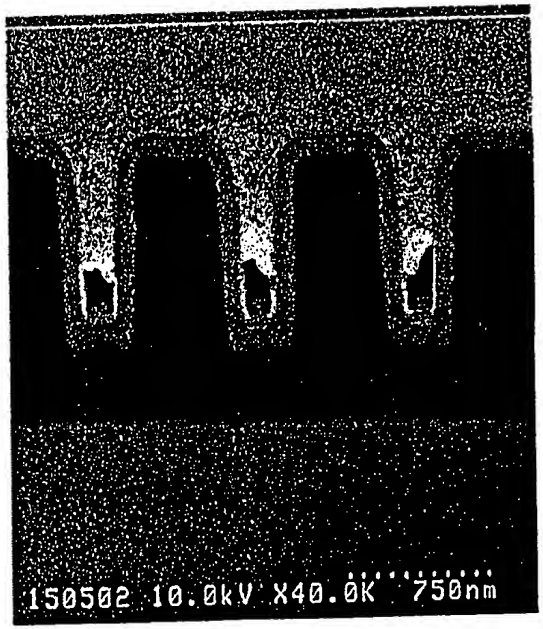
Initiation: Low current, 2 second induction



Field 2, 0.29 µm x 1.14 µm, AR = 4.0



Field 3, 0.24 µm x 1.13 µm, AR = 4.7
•Void % = 1.3 %



Field 4, 0.2 µm x 1.0 µm, AR = 5.0
•Void % = 15.8 %

- SEMATECH Backfilled via
- TI-IMP Seed
- 250Å Ta/ *1600Å Cu*

Electroplating

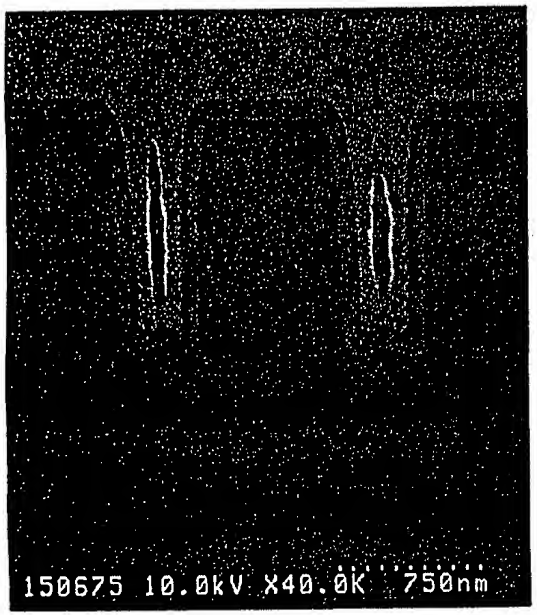
- *Step 1: 1 A for 15 sec*
- *Step 2: DC, 7 A*

Bath Conditions

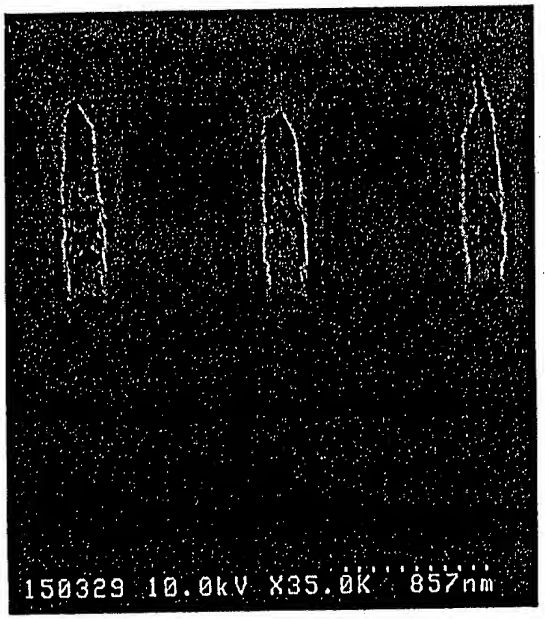
$[Cu^{+2}]$ = 17.3 g/l	H_2SO_4 = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
$[Cl^-]$ = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125

FIG. 52

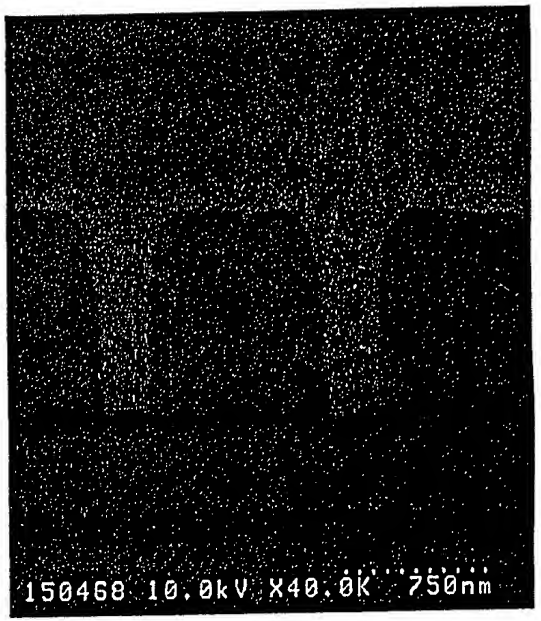
Initiation: Effect of Induction Delay



- *DC, 7 A , 0 sec induction*
- *Void % = 16 %*



- *DC, 7 A , 2 sec induction*
- *Void % = 53 %*



- *Step 1: DC 1 A, 15 sec , 2 sec induction*
- *Step 2: DC, 7 A*
- *Void % = 53 %*

- SEMATECH Backfilled via
- (Ti)IMP Seed
- 250Å Ta/ *1600Å Cu*

Field 2, 0.29 µm x 1.14 µm, AR = 4.0

Bath Conditions

$[Cu^{+2}]$ = 17.3 g/l	H_2SO_4 = 176 g/l
[MLO] = 3 ml/l	[MD] = 8 ml/l
$[Cl^-]$ = 55 ppm	Temp = 22 °C
Flow = 8 lpm	RPM: 125